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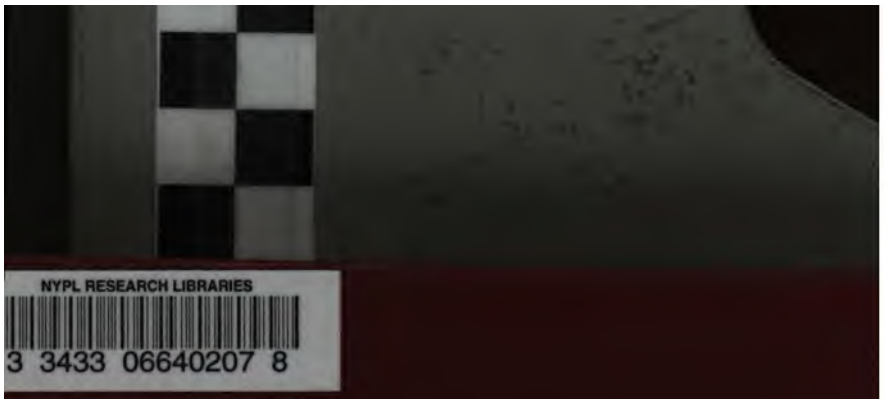
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# THE PRACTICAL COMPOUNDING

OF

# OILS, TALLOW AND GREASE

FOR

# LUBRICATION, ETC.

BY

AN EXPERT OIL REFINER

LONDON

PUBLISHED AT THE OFFICES OF THE *OIL AND COLOURMAN'S JOURNAL*

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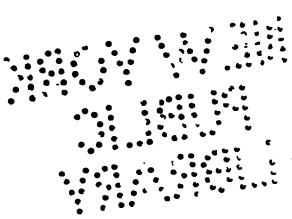

# PREFACE.

In consequence of the numerous applications and inquiries from the trade for a work embodying sound practical information for the successful manipulation of oils (lubricating and burning), tallows and greases, we have decided to issue this book.

In doing so we have carefully reviewed the whole field of resource and chosen therefrom the best material only for their manufacture.

This we have further dissected and classified into the respective groups, with the assistance of a practical expert, carefully avoiding, as far as possible, all technical phrases, aiming to so simplify the information given as to enable it to be easily followed and carried out.

In each section the respective values of the article or articles for burning or lubricating have been fully specified, so that in using them, either alone or combined, their working capabilities can be approximated.

In respect to the mineral oils, these have been specially chosen in order that from a few grades

the whole range of standard oils can be made, thus reducing stocks to a minimum.

Practical tests have also been specified, so that any marked degree of adulteration can be discovered. Simple methods, by which independent examination of oils, etc., can be made, are likewise given. There are also numerous recipes of reliable compounds, by which means a complete range of sound specialities are always attainable.

The purport of the book has been to treat as comprehensively as possible the subjects enumerated, and to give at the same time, to merchants and manufacturers in the different branches of these trades, practical hints for the general compounding of oils, also for the utilisation of waste products, such as ullages, etc.

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# THE PRACTICAL COMPOUNDING

OF

# OILS, TALLOW AND GREASE

FOR LUBRICATION, ETC.

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## CHAPTER I.

### INTRODUCTORY.

THE manipulation and blending of oils have, during the past few years, been completely revolutionised, owing to the attention science has given thereto.

Practically, this branch was ignored altogether by scientific men, as the ordinary lubricants, such as neatsfoot, lard, olive, sperm, rape oil, tallow, etc., were so well known and so universally adopted that there was no immediate need to trouble about the matter.

The discovery and introduction of hydrocarbon oils, however, speedily opened up a new field for research, so that this product might be utilised.

The result has been that these oils have, to a large extent, supplanted the older lubricants.

At the present time, the qualities on the market

are excellent, although low grades are being continuously drafted in ; but if the manufacturer or merchant buys to a specific standard only, such oils will speedily be withdrawn as lubricants.

In the old days, the belief was that the heavier the oil and the higher the specific gravity, the better.

Practical tests, however, prove that specific gravity carries no weight whatever, but that flash-point and viscosity alone are the only true guides to the value of any lubricant. Much improvement has also been made in the manufacture and refining of animal and vegetable oils and tallows.

A few years back it was nothing unusual to meet with oils and tallows containing from 10 to 15 per cent. free fatty acids, and in many instances mineral acids as well. Observation and experience have proved to the engineer that such ingredients in a lubricant are very hurtful to machinery, causing "pitting," etc. ; and, therefore, manufacturers will do well to take care and see that oils and tallows intended for lubrication are as neutral as possible.

If required for direct use, the percentage of free fatty acid, calculated as oleic, should not exceed 3 per cent., and not more than 5 per cent. if blended with mineral oils, and in no case should mineral acid be present.

Mineral oils should in every instance be perfectly neutral.

Now that technical education is making such rapid strides all over the country, and everybody is becoming his own chemist, the manufacturer is continually being besieged with specifications stipulating what is and what is not to be in the oil, tallow or grease supplied. Every little vestry, colliery or works of any size, and, in some instances, small consumers, are adopting this line of procedure, and issue tenders with specifications appended, some of which are very amusing; but it clearly proves that only those manufacturers who turn out the best goods at the lowest rate will hold their own in the future.

There is no doubt, now that the prejudice against the use of mineral oils is dying out, and that insurance companies have been forced to acknowledge their perfect safety, that quite 80 per cent. of the oils now used are hydrocarbon.

It has been found, however, that a slight percentage of fatty oil added to the mineral oil stops any tendency to carbonise that might otherwise take place by the use of mineral oils alone. This applies especially to oils used for cylinders, valves, etc., where the oil is confined and comes in contact with free steam.

In the manufacture of machinery and cylinder

oils too little attention is given to the grade of work they are called upon to perform. The system generally adopted is, on receipt of an order where nothing is specified, to send an oil according to the price paid, irrespective of its suitability, which often leads to after-trouble and annoyance, and in some instances the loss of the customer in the bargain. Great stress should be laid upon this point, and the necessity for the traveller, when soliciting orders, to make every inquiry as to the class of machinery for which the lubricant is required.

Such a need has been brought to the writer's notice very recently. An oil traveller called at a works, and found the principals engaged grumbling at the engineer because of the quantity of engine oil used, which, they stated, must have been wasted, as double the quantity was being used than formerly, and they appealed to the traveller to aid them in solving the difficulty. With great zest the traveller complied, and asked to see the oil then in use, and on its appearance at once condemned it as "trash," which coincided exactly with the engineer's views. He thereupon introduced a solidified oil, which he strongly recommended as being most economical, as its consumption depended solely upon the requirements of the machinery, and no more. An order

for one cwt., as sample, was given upon his recommendation and duly delivered, with the result that the shafting, etc., where it was applied, got so hot that the metal ran and jammed, causing a smash.

On investigation it was proved conclusively that the oil previously in use was in every way suitable for the work, and that the whole fault lay with the engineer, who had let the bolts and nuts get loose: hence the waste.

On the other hand, the solidified oil was found to be wholly unsuitable, on account of its high melting-point, and that no lubrication whatever took place until the oil liquefied, when it speedily ran through, leaving the bearings quite dry.

The result of this was the firm which the traveller represented lost a new customer, besides doing them considerable harm amongst other manufacturers in the town, and nearly landed them into a lawsuit in the bargain, for damages.

Therefore it is of the utmost importance to see that every traveller is thoroughly conversant with the articles he has to sell, and has them so classified that he can at once present the grade requisite for the work the machinery has to do, it being a well-known fact that ninety-nine out of every hundred customers give scarcely any attention to the matter so long as things run smoothly,

they trusting more to the manufacturer or engineer to supply what is required.

Solidified oils, in particular, require special attention in this respect, as it is impossible for any lubrication to take place until the melting-point is reached, therefore, as far as possible in every case where these are used, the maximum temperature which the machinery attains in running should be ascertained, so that the nearest grade to that temperature can be supplied.

The writer proposes to treat the subjects enumerated as comprehensively as possible, and to give at the same time such practical hints as will be found useful to the merchant and manufacturer, in the development of their business.

## CHAPTER II.

### HYDROCARBON OILS.

THE writer purposes passing over the modes of manufacture of these oils, as the majority of those on the market have been already refined for use before importation, the crude residuum being in the hands of syndicates, therefore preventing its profitable working here.

Lately, however, a company has been formed near London, for the manufacture of lubricating oils from Russian crude oil, but up to the present nothing has been seen of the promised article.

The three sources from which the hydrocarbon oils come are America, Russia, and Scotland.

There is no doubt that the best all-round oils come from America, although Russian oils have been considerably improved of late.

Scotch oils are, to a certain extent, barred from extensive competition, on account of the few qualities made, but if the oils were improved a readier

sale would ensue, and better prices be obtained—a hint to which the refiners would do well to give their attention, as at present there is a great objection to the smell, especially when under heat, which is very offensive.

By removing more of the light oil the flash-point would be raised, and the general tenor improved, which at present, even in the ·903 grade, goes very little higher than 350° F., open test.

The viscosity also at 140° F. is very little more than the American ·885 at the same temperature.

The great feature of the Russian lubricating oils is their high viscosity at ordinary temperature, also their low cold test at zero, remaining quite fluid, which, for refrigerators and winter use, gives them a prestige over American oils, very few of which remain fluid below 32° F.

The best and safest brand of Russian lubricating oils on the market is Nobel's, who turn out very fine, high-class, reliable grades.

Their No. 1 pale quality has a specific gravity at 60° F. of ·908/·910, and a flash-point of over 380° F., whilst their No. 2 goes over 330° F., both close test, with a specific gravity of ·895, equalling those of the American oils of like gravity.

In viscosity, however, the No. 1 is superior even to Thompson & Bedford's Bayonne, sold by the

Anglo-American Oil Company, Limited, from which a comparison of American oils with those of Russian will be drawn.

At 70° F. the viscosity of No. 1 Russian is 40 per cent., and at 140° F. 28 per cent. better than Bayonne.

The No. 2 Russian also, in comparison with ·903/·907 American, shows at 70° F. 38 per cent. better, and at 140° F. exactly equal value.

In actual working, however, it has been found that the Russian oils, when used alone, have a tendency to clog. This can be easily overcome by the blending of the oils of the two countries together in equal proportion, or otherwise if desired, which entirely removes this evil.

Much useful blending can be accomplished in this manner, as what the Russian oils lack in flash-point they make up in viscosity, so that many of the high-grade American oils, for which fancy prices are asked, can be matched at a much cheaper rate.

There is also a red quality Russian oil of ·920 specific gravity with a close flash-point of 420° F. and a viscosity equal at 212° F. to the American extra filtered cylinder oil, and superior at lower temperatures, which will be found very useful for mixing purposes.

In filtered amber cylinder oils the brands

named stand well; but where dark cylinder oils are used, the Russian qualities run them very close—in fact, beat them in some respects.

The dark Russian machinery oils, however, require very careful watching when bought, as there is a great effort at the present time to try and foist oils of the "Astartki" grade upon the unsuspecting buyer, which are practically useless except for chains and such common work, the flash-point in some instances being as low as 120° F.

To give satisfactory lubrication no black oil should be used that flashes under 300° F., to which such oils as Nobel's residuum and Anglo-American Company's summer dark conform.

In taking flash-points the best instrument to use is a Gray's machine, and for viscosity Redwood's viscosimeter, which are the recognised standard instruments used by the trade, Government and leading railway companies, etc.

The Government departments, however, in taking flash-points, adhere more to Abel's apparatus, that being the instrument approved by the Board of Trade. Between this instrument and Gray's there is a difference of 15° in close-test flash-points—Abel's being the lower—which must be allowed for when using the latter machine, although Gray's is decidedly more reliable and accurate, being also much cheaper.

It would pay every manufacturer to invest in the above instruments, as they are most essential both in buying and selling, requiring no technical knowledge to work, full instructions being furnished with each instrument.

The temperature at which viscosities are generally taken for machinery oils is 70° and 140° F., and cylinder oils 180° and 212° F.; these being the nearest minimum and maximum temperatures, respectively, the oils meet in actual work.

The best standard for comparison is distilled water at 60° F., taking this as unity.

The actual blending must be left to the individual manufacturer, as each one seems to prefer making up to his own particular standard, but this could be greatly facilitated and improved if a careful test were made of each of the respective qualities on the market, and registered, so that oils of any desired viscosity could be made by simple calculation and division of the various quantities used, thereby enabling much less stock to be kept.

The actual flash-point, however, cannot be arrived at in this way, as the tendency is always for the lighter oil to separate on heating, so that no compound will exceed very much the minimum flash-point of the various oils used, a fact practically ignored, and by some people little known,

judging by some of the oils the writer has tested.

On no account should the buyer trust to the tests furnished by the sellers, as they are invariably "puffed" and unreliable, but should obtain the tests accurately himself, and so be sure of them, by which great saving of time and money will be effected, when once obtained.

By making a rule also of testing everything bought, the manufacturer knows exactly how he stands, and is in a position to reoffer the oils to his customers, with the fullest confidence of giving them, at all times, complete satisfaction.

From the American ·870 neutral and Queen's spindle, in conjunction with the Russian ·908 and ·920 oils, the bulk of the pale machinery oils can be made, if blended in proper proportions, equal in every respect to the American standard qualities, *e.g.* :—

AMERICAN SUMMER DARK OIL.

1 Queen's spindle,
or clarified ullages from barrels, tanks, etc.,
1 Nobel's residuum.

AMERICAN WINTER DARK OIL.

1 Neutral oil,
or clarified ullages from barrels, etc.,
2 Nobel's residuum.

AMERICAN A CYLINDER OIL.

1 N. cylinder oil,
1 Nobel's residuum.

PALE VALVE AND CYLINDER OILS.

The American extra filtered cylinder oil in conjunction with the pale machinery oils is quite sufficient for making any of the above.

AMERICAN COSMOS CYLINDER OIL.

1 No. 1 Russian oil,
1 Extra filtered cylinder oil.

PALE MACHINERY OILS.

·885 *Spindle Oil.*

3 Queen's spindle,
2 Neutral oil.

·903/·907 *Machinery Oil.*

3 No. 1 Russian oil,
1 Queen's spindle.

*Heavy Valve* (*H.V.*).

2 No. 1 Russian oil,
1 ·920 Russian oil.

*Bayonne.*

1 No. 1 Russian oil,
1 ·920 Russian oil.

DARK MACHINERY AND CYLINDER OILS.

The two qualities requisite to stock, from which any grade can be made as desired, are as under :—

Nobel's Russian residuum,
American N. cylinder oil.

F.F.F. VALVE OIL.

1 Heavy Russian ·920 oil,
1 Extra filtered cylinder oil.

Hydrocarbon oils, when used alone, do not, as a rule, give as satisfactory a result as when judiciously blended with a fatty oil; but as expert opinion is divided upon this matter, the writer gives below a classification of the grades most suitable for the various classes of machinery to which the fatty oil can be added if desired :—

LIGHT PALE OILS.

*Minimums.* — Specific gravity, ·880/·885; flash-point, 350° F.; viscosity at 140° F., 1·0; water = 1·0.

Looms,
Spindles,
Sewing machines,
Screwing machines, etc.

MEDIUM PALE OILS.

*Minimums.*—Specific gravity, ·900/·905; flash-point, 360° F.; viscosity at 140° F., 2·0; water = 1.

Light shafting,
Engines under 5 H.P.,
Gas engines,
Lathes, etc.

HEAVY PALE OILS.

*Minimums.*—Specific gravity, ·905/·910; flash-point 370° F.; viscosity at 140° F., 3·0; water = 1·0.

Traction engines,
Stationary engines over 5 H.P.,
Dynamos,
Heavy bearings.

### Extra Heavy Oils.

*Minimums.*—Specific gravity, ·910/·920; flash-point, 400° F.; viscosity at 140° F., 5·0; water = 1·0.

Quadruple and triple expansion engines,
High-pressure marine engines,
Valves and cylinders,
Hydraulics, etc.

### Heavy Black Oil.

Flash-point not under 300° F.

Trucks,
Chains,
Trams,
Vehicles, etc.

### Cylinder Oils.

With the above the specific gravity is no guide to viscosity, nor is it so in any oil under the influence of heat. The following tests, taken by the writer on the principal standard qualities at various times, give a general conception of value:—

| Thompson & Bedford's. | Sp. Grav. | F.-point. (close). | Viscosity (Water = 1). 140°. | 212°. |
|---|---|---|---|---|
| Extra fil. cylinder oil | ·895 | 506° F. | — | 3·4 |
| F.F.F. valve oil | ·895 | 468° ,, | — | 3·1 |
| Cosmos cylinder oil | ·875 | 440° ,, | — | 2·7 |
| N. cylinder oil | ·900 | 520° ,, | — | 3.5 |
| Bayonne oil | ·915 | 405° ,, | 2·7 | — |
| H.V. oil | ·908 | 400° ,, | 2·5 | — |
| ·903/·907 oil | ·905 | 390° ,, | 2·0 | — |
| Queen's spindle oil | ·895 | 384° ,, | 1·7 | — |
| ·885 spindle oil | ·886 | 360° ,, | 1·4 | — |

| Nobel's. | Sp. Grav. | F.-point. | Viscosity. 140°. | 212°. |
|---|---|---|---|---|
| No. 1 Russian oil | ·908 | 405° F. | 3·6 | — |
| No. 2 ,, ,, | ·896 | 360° ,, | 2·0 | — |
| Heavy Rus. cylinder oil | ·920 | Close. 420° F. | — | 3·4 |

## Rough Practical Tests.

*Specific Gravity.*—This is always taken at 60° F., that being the normal temperature. In general practice an hydrometer is used, this being sufficiently near for ordinary purposes.

*Gravimetrical Temperature.*—To calculate for any rise or fall of temperature, first register the specific gravity with the hydrometer and ascertain the temperature of the liquid, and if below 60° F. deduct for every 2° 1 from the hydrometrical register, but if above add thereto in the same ratio.

*Tests for Purity.*—Shake a little of the oil up in a caustic soda solution, which should separate, on standing, quite clear, forming no emulsion whatever, if wholly a mineral oil.

Should, however, soapiness occur, it denotes the presence of some fatty body.

To ascertain roughly the percentage present, take a known quantity and mix therewith an equal proportion of 1·840 sulphuric acid and allow to stand, after thoroughly stirring together with a glass rod, in a graduated measure (25 c.c.), when the various oils will separate, and can be read off.

*Percentage.*—If 5 c.c. or parts of oil be taken for examination, this, after treatment as described above, shows on settling (minus added acid)—

$4\frac{1}{2}$ mineral oil,
$\frac{1}{2}$ foreign substance,

the 100 being represented by 5 (the total amount examined); the proportionate parts per cent. are arrived at as under:—

$$4\tfrac{1}{2} \times 100 = 450 \div 5 = 90{\cdot}0 \text{ mineral}$$
$$\tfrac{1}{2} \times 100 = 50 \div 5 = 10{\cdot}0 \text{ unknown}$$
$$5 \qquad\qquad 100{\cdot}0$$

*Adulterant.*—The quickest and easiest way to discover what the foreign substance in any oil consists of is first to pick out such oils that will compare favourably in price, colour and quality with that under consideration, such being the most likely to be present, thereby confining the search to a very small compass, and therefore greatly facilitating the chances of a correct discovery.

In this instance the only oil applicable would be resin, or a metallic oleate, both of which are soluble in glacial acetic acid.

To confirm this supposition, take a further 5 c.c. of the original oil and shake up with 20 c.c. acetic acid and allow to settle, when any loss of the oil will confirm their presence, and also denote conclusively the actual quantity contained therein.

*Physical Test.*—This is one of the keenest rough tests extant, as a very close conception of the

actual basis can be arrived at in this way: Pour about ten drops of the oil upon an iron plate and heat up to about 200° F., at which temperature the smell of the oil or oils present will be very marked, and, by continuous practice, combined with a general knowledge of the various standard grades, clearly defined.

*Taste.*—Combined with above, any uncertainty that might arise in smell is generally thus overcome, as the palate is very crucial and rarely fails to detect and also define foreign matter.

*Flash-point.*—This can be ascertained roughly as follows: Take a small evaporating basin and fill three parts full with the oil, then heat very gently on a sand bath or wire gauze over a Bunsen or spirit flame, suspending a thermometer therein so that the bulb thereof is immersed midway in the oil, but clear of sides and bottom of basin.

As the heat rises, pass a small flame carefully over the surface, without actually touching the liquid, until it flashes. (This is easily made, where gas is available, with an india-rubber pipe having glass tubing inserted in one end and drawn out to a fine point, the flame from which should not exceed one-eighth inch in length, whilst the other is connected with a gas burner.) Note immediately what the glass registers, as this is the flash-point—open test.

It is always advisable to take the same twice, so as to be sure of its correctness.

The close test is generally from 15 to 25 degrees lower.

It is necessary to keep the draught away as much as possible, as it materially affects the attainment of accurate results.

*Fire Test.*—This is simply an extension of the above, the heat being continued until actual ignition takes place.

*Viscosity.*—This can be ascertained very accurately as under:—

Purchase an ordinary glass carbon filter, also a 20 c.c. Mohr's burette in one-tenth degrees fitted with Geissler's stopcock. Bore a hole in a cork sufficiently large to insert the burette, which then fix into centre of filter, leaving the stopcock outside, making the cork water-tight with plaster of Paris. Having done that, fill the outer bath with a light mineral oil (·885), this being much better than water, as it retains heat longer, as well as more uniformly, and when hot is not so liable to break the glass.

To heat the oil, the best way is to draw off small quantities with a syphon, as required, into a beaker or saucepan, and warm separately, thereby raising the temperature of the bath to the desired working degree.

To standardise, fill the burette up to the top graduated mark with distilled water, and if its temperature and that of the outer bath stand at 60° F., run off, at full bore, 15 c.c., noting the time taken by the aid of a stop-watch. Having done this three or four times, accept the average as correct.

Supposing the time taken was five seconds, the water unity of that machine would therefore be 5·0, by which all future tests are governed.

The viscosimeter is now ready for use, and should, if carefully worked, give results equal to the best high-priced standard machine.

Fill burette with the oil to be tested as described for water, then heat oil in outer bath to desired temperature, and when both are equal run off 15 c.c. and check in the same way as done with water, dividing the total time by 5, which gives its viscosity in comparison with water; *e.g.*, 15 c.c. oil run off at 140° F. took 18 seconds, which, divided by 5, shows the viscosity to be 3·6, as against water 1·0, at 60° F.

Machine oils are taken at 70° F. and 140° F.

Cylinder oils are taken at 212° F.

Always filter the oil before testing, so as to free it from dirt, etc., which, if present, affects it considerably, and prevents a true result being obtained.

Be careful to ascertain also with a thermometer whether both oils are of equal temperature before taking the viscosity, and that the full 20 c.c. is registered in the burette.

In high temperatures it is advisable to have the outer bath some 2 degrees higher than the limit required, which necessitates continuous agitation to ensure uniformity.

*Acidity.*—Mineral oils should not contain any acid whatever, but be quite neutral. (*See* p. 51 for test.)

## CHAPTER III.

### ANIMAL AND FISH OILS.

In spite of the large percentage of mineral oils now used for machinery, there is still a wide field wherein animal and fish oils cannot be dispensed with, especially for leather, and also in the textile trades, where only saponifiable oil can be satisfactorily used.

There are also still many firms who use them extensively, and will continue to do so if a thoroughly good oil is supplied, as there is no doubt they are vastly superior to hydrocarbon oils for lubrication (cylinders excepted), as their high flash-point, viscousness and tenacity cause them to work with greater uniformity and with considerably less friction, thereby keeping the machinery cooler.

The present price of these oils should bring them again to the front, as they are now much the cheaper of the two in actual use—a fact no doubt discredited by many, but amply proved by practical demonstration on some of the best machinery in the kingdom.

If merchants, in buying neatsfoot, lard, animal and tallow oils, would determine to accept only those oils of the highest purity and neutrality, they would find the manufacturers speedily rise to the requirement, as the quality of the oil depends solely upon the class of raw material used, which, if properly and suitably chosen, would enable them to manufacture oils of the highest grade.

At present there is a quantity of footy and acidy oils on the market which are totally unfit for lubrication.

The horse oils also, which are now being pushed forward so zealously, are very inferior, containing much gelatinous matter, as well as a high percentage of free fatty acid, thereby retarding their extensive use as lubricants.

The only fish oil suitable for lubricating machinery is sperm, owing to the gummy nature of seal, whale, cod, etc., all of which, however, are largely used for burning and numerous other purposes, such as steel-hardening, etc. The introduction of bottle-nose or Arctic sperm oil has entirely swept away the high prices this oil used to command.

As a lubricant, there is very little, if anything, to choose between the Arctic and Southern oil when well refined, both of which find a ready sale in the textile trade for spindles and looms.

Both animal and fish oils should have a flash-

point over 500° F., which is one of the best tests of purity, combined with that of specific gravity.

Such oils, either for direct lubrication or compounded with other oils, will always find a ready sale.

SPECIFIC GRAVITY, FREE FATTY ACID PER CENT., VISCOSITY AND FLASH-POINT.

| | | Free Fatty Acid (Oleic). | | Viscosity. Water at 60° F.=1. | | F.-pt. |
|---|---|---|---|---|---|---|
| | Sp. Grav. at 60° F. | Actual. | Average. | 70° F. | 140° F. | (open). |
| Neatsfoot oil | ·914 to ·917 | 1 p.c. | 1 to 5 p.c. | 10·3 | 2·5 | 510° F. |
| Lard oil (English) | ·914 to ·916 | 3 p.c. | 0 to 1 p.c. | 9·0 | 2·0 | 540° F. |
| Tallow or ox oil | ·912 to ·914 | 2·1 p.c. | 1 to 3 p.c. | 10·0 | 2·4 | 512° F. |
| Sperm oil (Arctic) | ·880 to ·882 | 0·1 p.c. | 1 to 3 p.c. | 4·4 | 1·8 | 502° F. |

The above oils were of known purity and well refined, so that they can be safely taken as representative standards in making comparison tests.

## CHAPTER IV.

### COMPOUND OILS.

To attempt, in this book, a complete dissection of the numerous compounds sent out by the various manufacturers would be impossible; therefore, the writer proposes to dwell upon them simply in the form of a synopsis, separated into sections, thereby covering the multitudinous uses to which such oils are put, at the same time giving the various percentages best suited for a first-class oil in each department, which can be either increased or decreased, according to price or other circumstances, as desired.

When mineral oils were first introduced, it was presaged that animal and vegetable oils would become a thing of the past for lubrication.

This has not by any means been fulfilled, nor likely to be, as experience shows that, by their judicious blending with hydrocarbon oils, a greater uniformity of lubrication is attained, and that less quantity is required than by the use of a pure mineral oil alone.

To enable a full and comprehensive syllabus to be worked out with simplicity, it will be better to separate the grades of lubricants suitable for marine engines, etc., from those of land.

## Marine Engine Oils.

Marine engineers approve only of those oils that lather freely when shaken up with water, which is the principal test applied by them, a peculiarity with castor oil, that being their ideal of a perfect lubricant.

It is necessary, therefore, in the preparation of marine engine oils, to see that they conform to this test, otherwise they are sure to be rejected.

As castor oil is very difficult to blend with mineral oil—in fact, impossible, without the aid of an animal or vegetable oil, and only then in certain quantities and under special conditions, to prevent its separating—thickened rape and lardine oils are therefore found more suitable in conjunction with mineral oils.

The nauseous smell, however, given off by lardine in working, and the similarity of action to castor when blended alone with the majority of mineral oils, have retarded its extensive use for marine lubrication. Thickened rape, however, is in large demand for this purpose, and gives every satisfaction, as, when blended with mineral oils, it

freely combines, and at the same time generates the necessary lather required.

No mineral oil should be used for the purpose of making marine engine oils that flash under 380° F. close test, the disregarding of which in the past has led to no end of trouble, and is the cause of its being difficult now to induce steamship companies to make a change, however great the advantage may be, as the responsibility is, they state, too great to hazard, unless the manufacturer is prepared to take the risk of any breakdown that might occur on the voyage, which, of course, is declined.

To a certain extent the steamship companies' stand is justifiable, as some of the oils supplied have been, to use mild language, "rubbish," and wholly unfit for marine engines, or, in fact, any, as the flash-point in some instances has not exceeded 270° F., which requires no comment as to the quality of oils used in their preparation. Machines that are continuously running, like marine engines, for long periods, require the very best lubricant that can be obtained, as it is impossible to stop them when once started, like those on land.

Viscousness and tenacity are very essential points, in conjunction with high flash-point, necessary for the making of a good oil, so that only

those mineral oils, such as Nobel's No. 1, should be used for this purpose.

An oil made of—

75 per cent. mineral,
25 per cent. thickened rape,

is a very good mixture, and one that has been well tried and still used extensively. But of course this would not be suitable for every grade of engine, and would require adjustment according to the respective horse-power.

It is given, however, as a minimum quality, and can of course be easily improved upon as desired, even up to the maximum blend of—

40 per cent. mineral,
50 per cent. thickened rape,
10 per cent. tallow oil.

The writer recommends, even in the lower blend, a small percentage of tallow or animal oil, which would be found an improvement at a very slight additional cost, and therefore amends this mixture as under :—

70 per cent. mineral,
25 per cent. thickened rape,
5 per cent. tallow oil.

For valves quite a different oil is required, and the compound that has given the most satisfaction is—

45 per cent. American ·903 to ·907,
45 per cent. Nobel's No. 1,
10 per cent. refined rape,

and is well worth adoption.

For cylinders, especially those of the triple-expansion type, 10 per cent. tallow or animal oil to the cylinder oil has been found very beneficial, as it stops effectually any tendency to carbonise that sometimes happens when using simply virgin oils, which in no case should have a flash-point under 450° F. close test.

By giving special attention to the foregoing points, it would simply be a question of time to regain the confidence of the steamship companies, especially if a free trial were allowed in first instance, so that a footing could be obtained, from which, if satisfactory, further recommendations would speedily follow, and so gradually split up the present monopoly, which certainly should not be allowed any longer to continue.

## Locomotive and Stationary Engines, Looms, Spindles and General Machinery.

To successfully cater for the varied lubricants requisite for the multifarious kinds of machinery now extant, is no easy task at a moment's notice, unless some previous classification has been accomplished.

It is not only essential to do this, but also, as far as possible, to keep a daily record of any information received from travellers or customers respecting the lubricant supplied or required, as this will be found invaluable.

Some firms keep quite a ledger of such reports, and find them of great service, especially now that competition is so keen.

As an instance of benefit so derived, the following was told to the writer by a principal of one of the leading firms, as proof of its utility :—

In one of the towns where their traveller called it was noticed that no orders were ever received from one section of manufacturers, although reported as regularly called upon, and therefore the principal decided to go down and ascertain, if possible, the cause.

Arriving very late, he was forced to put up anywhere, and on inquiring at an old-fashioned hostelry, found he could be accommodated.

Whilst waiting for supper, he went into a private room, and there found himself in the midst of at least a score of gentlemen who, he afterwards ascertained, were principals and managers of the very firms whose orders he desired, who met there once every week to discuss business topics. Curiously enough, the subject then under discussion was lubricating oil, which was giving them

trouble on a new article they were manufacturing at that time.

Of course, although apparently disinterested, every nerve was strained to catch the point each person was putting forth as to where the failure lay, and its remedy, but just as the crucial stage was being reached, supper was announced, and he had to reluctantly leave, and so lost the pith of the argument.

Feeling much annoyed, he had no alternative but to return to town; but, to his satisfaction, on referring to the traveller's registered information, gathered from time to time, he found the missing link required to enable him to supply a suitable article, with the pleasing result that the traveller is at present drawing an extra £30, and the firm's business has increased some £400 annually from this town alone.

This narrative will no doubt be pooh-poohed by many, or accepted merely as a slice of luck; but as numerous other instances, where benefit was traced directly to such registered information, were conclusively pointed out to the writer by the same firm, he is convinced of its efficiency, and the need of such a system becoming wider known and adopted.

The firm in question attributes to a large extent its present standing and progress to this system

of registration and classification, which other firms will do well to copy.

The American system of gradation is well worth following in the classifying of the various oils, as it simplifies the final location considerably.

Their mineral oils are divided into three grades, *viz.*, light, medium, and heavy, which to the consumer is of great assistance, but for the manufacturer this is not sufficient without knowing also the exact lubricating value.

This is best arrived at by arranging the specific gravities, flash-points and viscosities in a gradual rising scale, and finally dissecting the respective qualities into their relative channel, which will enable an oil suitable for any requirement to be chosen immediately.

Surface pressure, temperature and speed are the most important points to ascertain from customers, also their particular trade.

Standard qualities should be made of each section and tested continually for uniformity, and, wherever possible, improved, as only by the adoption of such a system can a sound business be built up, present customers retained, and new ones secured.

### Locomotives.

A very heavy oil is required, especially for the lubrication of engines of the compound type, which includes those running express trains.

There is at present, however, a diversity of opinion amongst locomotive engineers as to whether a pure hydrocarbon or compound oil gives the best result, but, judging from the great speed attained and the time of running, a compound oil would be more suitable in resisting the enormous friction occasioned.

The leading English railway companies are rapidly adopting the plan of making their own lubricants, simply buying the necessary oils required by specification.

In the case, however, of foreign and colonial railways, the viscosity of such oils should be never less than six times that of distilled water at 140° F.

The cylinder oils recommended for marine engines given in the present work are likewise suitably adapted for locomotives.

### Stationary Engines.

For these a great deal depends upon the working horse-power as to the grade of lubricant requisite.

The three following blends will, however, be

found generally suitable to meet the respective requirements, except for gas and electric engines.

*Engines of* 1 *to* 5 *H.-P.*

50 per cent. American ·903 to ·907,
25 per cent. Nobel's No. 1,
25 per cent. animal oil.

*Engines over* 5 *and up to* 10 *H.-P.*

50 per cent. Nobel's No. 1,
20 per cent. American ·903 to ·907,
20 per cent. animal oil,
10 per cent. thickened rape.

*Engines over* 10 *H.-P.*

50 per cent. Nobel's No. 1,
35 per cent. thickened rape,
15 per cent. animal oil.

If required still heavier, take away 20 per cent. Nobel's and replace with American cosmos or an oil of equal viscosity and fire test.

If desired for cylinders as well, use, instead of thickened rape, an equal proportion of American filtered cylinder oil.

Some engineers, however, object to thickened rape, in which case use castor instead.

These percentages have taken years to compile effectually so as to give entire satisfaction; and if hydrocarbon oils alone are preferred, it will be found that a similarity in viscosity to above compounds will prove invaluable for this class of work.

### Gas Engines.

It is much better to have two qualities of oil for above, so as to suit engines of less than 4 horse-power, as well as those of heavier build, for which the following are recommended as being equal in every respect to the well-known standard oils :—

*No.* 1.—*For Engines up to* 4 *H.-P.*

85 per cent. ·903 to ·907,
10 per cent. sweet Arctic sperm,
5 per cent. cocoa-nut oil.

*No.* 2.—*For Engines above* 4 *H.-P.*

50 per cent. Nobel's No. 1,
30 per cent. American ·903 to ·907,
15 per cent. Arctic sperm,
5 per cent. cocoa-nut oil.

### Dynamos, etc.

Oils for this class of machine, and, in fact, all lubricants for electrical machines, require special care in preparation, as the smallest piece of grit or gummy matter will cause no end of damage.

Drums and barrels should be scrupulously clean, and the oil carefully strained through a hair sieve when filled therein. The finest oil for this purpose the writer has ever seen was made up as follows :—

30 per cent. Nobel's No. 1,
30 per cent. American H.V.,
20 per cent. Russian ·920,
20 per cent. refined lard.

Pure hydrocarbons are most unsuitable for this purpose, unless in conjunction with some fatty oil, of which the minimum of 15 per cent. and 20 per cent. maximum have been proved to be the requisite percentages necessary to effectually stop carbonisation, which action, when mineral oils alone are used, speedily takes place.

### Spindle and Loom Oils.

For ordinary purposes an oil of the specific gravity ranging from ·890 to ·900 is sufficient.

Olive and sperm find great favour amongst spinners, and it is therefore advisable to flavour the lubricant with one or other of these oils.

The two following mixtures are largely used :—

90 per cent. American Queen's spindle,
10 per cent. Spanish olive.

---

90 per cent. ·903 American,
10 per cent. sweet Arctic sperm.

When stainless oils are required the percentage of mineral oils should be as low as possible.

An oil that leaves no stain is made of—

40 per cent. ·840 American neutral,
30 per cent. refined cotton,
20 per cent. Candia or Spanish olive,
10 per cent. 1st pressing castor.

The cost of this compound, although slightly above the average, is cheaper in the end, as it can

be relied upon, which in textile work is very necessary.

CLOTH OR WOOL-BATCHING OIL.

*Pale.*

84 lb. ·885 mineral,
24 lb. Yorkshire wool grease,
4 lb. water,
Containing $\frac{1}{4}$ oz. pearl ash
(carbonate potash).

*Dark.*

84 lb. blue oil
(from candle distillation),
24 lb. Yorkshire wool grease,
4 lb. water,
Containing $\frac{1}{4}$ oz. pearl ash.

Warm oil and grease to 120° F., and then add water, well crutching until temperature drops to 90° F. Air is the best agitator if available.

SHAFTING, ETC.

It seems to be quite customary for the trade to send out practically any oil for this class of work, with the idea of its being found suitable.

In one sample examined by the writer there were no fewer than seven different oils, evidently recovered tank bottoms—resin oil predominating—which when in use caused the shafting to squeak (as the principal stated) equal to the noise of a Chicago pig slaughterhouse.

A good oil for this purpose, which one firm has for several years sold without a single complaint, is made of—

80 per cent. ·903 American,
20 per cent. neatsfoot oil.

### Bicycle and Sewing Machine Oil.

The same oil should be suitable for both machines.

There is still a great need for a thoroughly good oil for these machines. In the case of the bicycle it should answer both purposes, *viz.*, that of lighting and lubrication.

The majority of the existing oils gum considerably, and in many instances have far too heavy a body for such work.

The specific gravity should in no case exceed that of sperm, and if ten points lower would be more near the mark, if the fatty element can be maintained at that gravity.

The writer's ideal of a lubricant for this grade of machinery is made up of—

30 per cent. mineral colza,
20 per cent. ·840 American neutral,
30 per cent. sweet Arctic sperm,
20 per cent. castor,

which remains fluid practically at all temperatures, and is a good lubricant and burning oil.

To give this a pleasant smell a scent composed of—

1 oz. oil of lavender,
4 oz. oil of citronelle,
4 oz. oil of myrbane,
1 oz. oil of sassafras,

should be added, using for each barrel from 6 to 8 oz.

Every day the question of perfect lubrication at the smallest possible minimum cost is becoming more and more prominent, and therefore it behoves the manufacturer both practically and scientifically to keep well to the fore, so as to be in a position to successfully cope with each new phase as it arises.

## Practical Hints.

*Mixing.*—In compounds containing castor, thickened rape or lardine oils, before adding these, always mix the other ingredients that may be used with the mineral oil first, otherwise a complete amalgamation will probably not take place, but they will separate out again on standing.

It is always advisable (especially during the winter months) to warm the oils slightly when mixing, as their cohesion is rendered more rapid and effectual thereby, the temperature best suited for this purpose being from 80° to 90° F.

*Lardine and Thickened Rape*, with some of the mineral oils, refuse to blend alone, and require a percentage of another fatty oil to effectually marry them, 10 per cent. being generally found sufficient to achieve this end, that of tallow oil being the most suitable for this purpose.

The proportions of lardine and thickened rape used in compounds range from 20 to 50 per cent.

*Specific Gravity, Viscosity and Flash-point.*—Always bear in mind that although specific gravity and viscosity can be calculated and averaged, the flash-point cannot be so derived, being never much above that of the lowest flash-point oil used in the compound, *e.g.*:—

*Mixture*:—

| | Sp. Grav. | Viscosity. 140° F. | F.-pt. |
|---|---|---|---|
| 2 Russian oil - - - | ·908 | 3·6 | 405° F. |
| 2 Extra filtered cylinder - | ·895 | 10·4 | 530° ,, |
| 1 Neatsfoot - - - | ·914 | 2·3 | 504° ,, |

Specific gravity of compound

2 – ·908 = ·1816
2 – ·895 = ·1790
1 – ·914 = ·914

5 — 5)·4520 = ·904. Calculated.

Viscosity of compound

2 – 3·6 = 7·2
2 – 10·4 = 20·8
1 – 2·3 = 2·3

5 — 5)30·3 = 6·0.

| | | | |
|---|---|---|---|
| Flash-point of compound | 2 | - 405° F. | = 810 |
| | 2 | - 530° ,, | = 1060 |
| | 1 | - 504° ,, | = 504 |
| | 5 | | 5)2374 = 474·8° F. |

Taken *pro rata* the combined mixture works out as shown above.

If the exact proportions given were taken, the first two results should be correct, but the flash-point would only be 425° F. or thereabouts, a fact which numbers of manufacturers have found to their cost when the oil supplied has been rejected for this reason and thrown on their hands.

From the writer's lengthened observation in testing and preparing compound oils, he has been able to classify them collectively, so as to form a rough estimate of the increase gained over the minimum flash-point oil used without actual testing, which scale is given below, although at the same time he strongly recommends the true flash-point always being taken.

(1) Mineral oils flashing from 350° to 370° F., combined with lardine or thickened rape alone, show no practical gain; but with those flashing from 380° to 405° F., combined with lardine or thickened rape and animal oil, 4 to 7 points.

(2) Mineral oils flashing from 350° to 370° F., combined with castor, olive and animal oils, show a gain of 5 to 10 points, and with higher grades

flashing from 380° to 405° F., 10 to 15 points; but by adding cylinder oil thereto, in conjunction with above, the increase is some 10 points still higher.

It will be noticed that there is no perceptible gain derived when using lardine or thickened rape alone with mineral oils, on account of the oxygen they contain reducing their flash-point considerably, as the original oils range from about 550° and 500° F. respectively, whilst after being blown they register only about 400° F. and sometimes less.

### Facsimile Oils.

Olive machinery,
Castor machinery,
Sperm machinery,
Lard machinery,
Neatsfoot machinery, etc.

In making such oils always endeavour to retain the original smell of the pure oil, likewise, as far as possible, the specific gravity and appearance.

The mineral oils used for this purpose should be devoid of bloom, which can be covered by using 7 lb. nitro-naphthalene to each barrel.

The best oils for this purpose are the American ·885 and Russian ·895, which are very pale.

Warm the oil to about 120° F., and dissolve therein the deblooming agent. The best way to accomplish this is to place the naphthalene in a

fine sieve, and wash it through with the warm oil until completely dissolved, when it is ready for use.

Be sure and rinse out the barrel with the oil from the pan if it is to be put back again therein for storage or despatch.

The specific gravity of each oil will be found to have been raised some 10° by such treatment.

## Good Blends.

### Olive Machinery Oil (Specific Gravity, ·917).

2 – ·895 bloomless oil,
1 – ·960 lardine,
2 – Spanish olive oil.

### Castor Machinery Oil (Specific Gravity, ·950).

2 – ·960 lardine,
1 – ·903 bloomless oil,
2 – castor oil, 1st pressing.

### Sperm Machinery Oil (Specific Gravity, ·882).

1 – ·870 neutral oil,
1 – ·895 bloomless oil,
2 – sweet Arctic sperm oil.

### Lard Machinery Oil (Specific Gravity, ·916).

1 – ·870 neutral oil,
1 – ·960 lardine,
2 – lard oil.

### Neatsfoot Machinery Oil (Specific Gravity, ·915).

1 – ·870 neutral oil,
1 – ·960 lardine,
2 – neatsfoot oil.

First blend the foreign portions together, and neutralise carefully any smell by a few drops of the scent described on page 39, and then add the respective virgin oils and thoroughly mix at a temperature of about 80° to 90° F.

*Testing :—*


| | |
|---|---|
| Flash-point - - - - | see page 18. |
| Viscosity - - - - - | do. 19. |


TABLES OF SPECIFIC GRAVITY, VISCOSITY AND FLASH-POINT OF STANDARD OILS.


| | |
|---|---|
| Mineral oils - - - - | see page 15. |
| Animal oils and tallow - - | do. 24. |
| Vegetable oils - - - - | do. 50. |


SPECIAL OIL FOR MOTOR CARS, ETC.

| | Sp. Grav. |
|---|---|
| 3 Heavy Russian oil - - - - | ·920 |
| 2 No. 1. Russian oil - - - - | ·908 |

## CHAPTER V.

### VEGETABLE OILS.

A VAST improvement has been made of late years in the refining of rape, olive, cotton and castor oils, so that the percentages of free fatty and mineral acids are now very low.

If properly refined there should in no case be any trace of the latter acid.

The average percentages of free fatty acid generally found in the best known grades are as under, but occasionally low qualities creep in which contain much higher percentages than those specified; these should be rejected at any price, unless bought for the purpose of further refinement, as they are unsuitable for direct lubrication and also for burning, unless reduced with other oils so that the percentage does not exceed $2\frac{1}{2}$ per cent., calculated as oleic.

Refined rape oil, 1 to 3 per cent.
Filtered olive oil, 3 to 5 per cent.
Castor oil, 1st pressing (French), 1 to 4 per cent.
Refined cotton oil, *nil* to 1 per cent.

The writer recommends, for merchants buying for burning and lubrication, a maximum standard percentage of 2½ per cent. in rape and castor, and 5 per cent. in olive, which should not be difficult to obtain.

With refiners, however, the case is different, as it is in their hands to refine the oils to whatever standard they please.

As a lubricant, refined rape has lost ground considerably, being replaced by hydrocarbon oils, but what it has lost in its original state it has regained as a blown oil, being the best of the series.

The quality generally used for thickening is Black Sea or Ravison, although oil from East India seed is used as well—the former predominating.

It is advisable to purchase both grades and mix them together in equal proportions, or otherwise as required, as the free fatty acid in that made from Ravison oil sometimes is quite 6 per cent. and over. The difference in price between the two qualities is about £5 per ton.

Cotton oil is now pushed forward and sometimes used as a lubricant, although very sparingly on account of its great tendency to gum when exposed to the atmosphere, which prevents its active use.

As a blown oil, however, it is used much more

extensively, but its sale has decreased considerably of late, on account, to a large extent, of the quality deteriorating.

When first introduced as lardine its sale was enormous, as it was made simply from cotton oil, which it is supposed to be.

One of the large enterprising makers found, however, that Japan fish and other oils could be introduced in conjunction with cotton oil without surface discovery, and so effectually was this practised that sometimes it became difficult to trace the oil's origin, there being such a conglomeration of varieties and glutinous matter present.

After flooding the market in this way for some time as the genuine article, the complaints became so numerous that the majority of merchants discontinued its use, and it is now a question whether it will ever recover its lost prestige, as thickened rape is a much more reliable lubricant.

Nut and olive oils are also occasionally blown, but more for private use.

Respecting the oxidised smell complained of so much in blown oils, makers would find that, by the addition of 1 per cent. of a Spanish or Candia olive to the respective oils when blowing, and by keeping the temperature down to the lowest minimum above the oxidising point (170° to 180° F.), the resultant oil would have very little smell, especially

in the case of cotton oil, not exceeding the gravity of castor.

At this point, if carefully executed, the cotton can be blown fully equal to it in colour and smell, making an excellent substitute for machinery purposes.

Too much forcing is adopted by makers of blown oils without first studying the natural laws of atmospheric pressure and temperature, the idea being to accomplish the work in as small a time as possible.

This desire is only natural, but Nature's laws require obedience to successfully use its forces, and it is therefore necessary to exercise caution; otherwise, if some of the makers continue their present tactics, sooner or later an accident must occur, perhaps resulting in loss of life.

## Olive Oil.

The Government are amongst the most extensive users of this oil for lubrication, but in some departments they import the same direct.

Many steamship companies, especially on ships conveying frozen meat, use olive oil, on account of the sweet smell given off in working and the fact of its being also an edible oil.

It is also largely used in the textile trade, but it must be quite pure, although the percentage of

free fatty acid is not of so much consequence, as it is made up with an alkali into a milky consistency before usage.

When, however, used for lubrication the free fatty acid present should not exceed 5 per cent. It is, however, more often compounded with other oils when used for this purpose. The best grades to buy are Candia or Spanish; Mogador being more suitable for soap-making on account of the high percentage of fatty acid generally present in this quality, which sometimes exceeds 20 per cent.

### Castor Oil.

For lubrication, the price of this oil of late has been prohibitive, and a good many attempts have been made to replace it with a blown oil, but at present the success obtained has not been very marked.

It cannot, however, be used so extensively for compounding as it otherwise would be were it mixable with hydrocarbon oils.

Its amalgamation can, however, to a limited extent, be accomplished with the aid of a fatty oil, but not to the percentage one would wish. However, some very good compounds, containing up to 20 per cent. castor with mineral and animal oils, can be made if mixed at about 80° F. This

oil is also used extensively on steamships and for heavy machinery, belting, etc., as, although of great body and tenacity, it is free from the gummy tendency of other vegetable oils.

| | Maximum Sp. Grav. at 60° F. | Viscosity at 140° F. (Water = 1). | F.-pt. |
|---|---|---|---|
| Refined cotton oil - - - | ·922 | 2·2 | 540° F. |
| Lardine - - - - - | ·985 | 6·1 | 415° ,, |
| Refined rape - - - - | ·916 | 2·5 | 504° ,, |
| Thickened rape - - - - | ·975 | 4·2 | 408° ,, |
| Olive oil (Spanish) - - - | ·915 | 2·1 | 520° ,, |
| Castor, 1st pressings (French) - | ·964 | 5·3 | 530° ,, |

## Practical Hints.

*Testing Cotton, Rape, and Olive Oils.*—The specific gravity and flash-point are as good practical tests as can be applied to above, neither of which should go under 500° F. open test if absolutely pure, and should be looked upon with suspicion and carefully examined if materially below above temperature.

For mineral oils see p. 16.

*Cotton Oil in Olive.*—Place in a test tube 5 parts of the suspected oil, and add thereto an equal portion of 1·420 pure nitric acid, and shake them thoroughly together. If pure, the mixture will first turn ashy grey and then slightly yellow, but if it contains cotton oil a dark brown colour will appear as well, deepening in density according to the percentage present in the oil.

*Castor Oil.*—This oil, if pure, should wholly dissolve in methylated spirit in the proportion of one of the former to two of the latter, any part remaining undissolved being foreign matter.

*Thickened Rape and Lardine.*—For resin or mineral oil see p. 16.

*Mineral or Free Fatty Acid—Mineral Acid.*—Litmus paper will show the presence of the least trace of this acid by changing it from blue to red when dipped in the oil.

*Free Fatty Acid—Oleic.*—All oils containing free fatty acids are commercially calculated as above. To test for these prepare as under:—

(1) Weigh carefully $1\frac{1}{2}$ oz. (about 42 grammes) pure caustic soda, and dissolve it in distilled water, making it up to 800 c.c. at 60° F., which is then filtered and bottled off for use as required.

This quantity will be sufficient to neutralise 10 oz. (282 grammes) oleic acid.

(2) Dissolve as much phenol phthalein as will cover a threepenny piece in 4 oz. methylated spirit, and keep well corked for future use.

Having done this weigh carefully $\frac{1}{2}$ oz. of the oil or fat to be tested in a 100 c.c. beaker, and add thereto some methylated spirit (64 O.P.), also a drop or two of mixture No. 2, and warm slightly in a water bath, shaking the whole well together.

Then place some of mixture No. 1 into a 20 c.c. burette (Mohr's graduated $\frac{1}{10}$ degree fitted with a Geissler stopcock), and run contents very carefully drop by drop into the oil until it turns a pink colour, and remains so on being well shaken, which takes place immediately the oil is quite neutral.

For example, $\frac{1}{2}$ oz. oil (14 grammes) required 3·7 c.c. of No. 1 mixture to neutralise.

By multiplying this amount by 282 and dividing the total by 800 we thereby ascertain the amount of free fatty acid contained in the quantity of oil taken, providing there is no mineral acid present as well. Should such, however, be the case it will be necessary, after making a preliminary test, to take a further quantity of the oil and wash it well with warm water until the litmus paper remains unchanged on immersion therein, then to test it again, when the difference between the first and second results will be the amount of mineral acid it contains.

For example, $\frac{1}{2}$ oz. oil is taken. On testing with litmus paper it showed the presence of mineral acid. Quantity of No. 1 mixture required to neutralise, 3·7 c.c.

$\therefore$ 3·7 × 282 = 1043·4 ÷ 800 gives the amount of free acid present as 1·3 of the total taken.

A further quantity of the oil is now washed

with warm water, separated and filtered until the litmus paper shows no change.

½ oz. of this oil is now taken and again tested; the amount of No. 1 mixture now required to neutralise being 3·5 c.c. or 1·2 c.c. of the whole, the difference between the first and second tests being ·1, which now reads as follows :—

| | |
|---|---|
| Mineral acid - - - - - - | ·1 |
| Free fatty acid (calculated as oleic) - | 1·2 |
| Neutral oil - - - - - - | 12·7 |
| | 14·0 grammes. |

To ascertain the quantity per cent. proceed as under :—

Mineral acid ·1 × 100 = 10·0 ÷ 14 = ·7 per cent.
Free fatty acid 1·2 × 100 = 120·0 ÷ 14 = 8·5 per cent. or a combined total of 9·2 per cent.

The above, if taken carefully, should give fairly accurate results, but if required very fine the soda solution must be standardised with pure sulphuric acid in the proportion of 3 c.c. to 97 c.c. distilled water at 60° F., when 1 c.c. of the one should exactly neutralise a similar quantity of the other, to be perfectly correct, but for ordinary purposes the quantities stipulated give results sufficiently near.


| | |
|---|---|
| Viscosity - - - - - - | see page 50. |
| Flash-points - - - - - - | do. 50. |
| Rough tests - - - - - - | do. 50. |

## CHAPTER VI.

### LAMP OILS.

JUST in the same way as animal oils suffered by the introduction of hydrocarbon lubricants, so have colza and other burning oils been affected by their kindred luminants.

There is, however, only one of the series that is at present materially affected, and that is the 300° fire test oil, which in some instances has entirely taken the place of colza. Several blends have, and are, being made for collieries, containing some 50 per cent. ordinary paraffin, but these are most dangerous to use, as, on burning for any period, the rise of temperature causes them to vaporise, generally ending in the whole mass igniting.

With mineral colza or sperm—as the 300° fire test oils are sometimes called—the specific gravity of which ranges from ·825 to ·840, this danger is avoided. The ·840 and ·860 American neutral oils (the latter being known as imperial bloomless), also other grades of American or Scotch oils up to ·895 gravity, when debloomed, are likewise used for such purposes.

All the fish and vegetable oils, except sperm, are very sluggish by themselves in burning, therefore the addition of 10 per cent. mineral colza is more of an improvement than otherwise. This percentage, even by the most particular of the Government departments, is allowed, for this very reason.

Colza and rape, seal, whale or sperm oils are those principally used for burning, although olive and nut oils are occasionally used as well.

The free fatty acid of the whale, seal and sperm oils should not exceed 2½ per cent.

In the two former oils the actual percentage rarely exceeds 1 per cent. in the pale qualities, which are the only grades suitable for making burning oils, the darker qualities containing albumen.

A "non-congealable" cotton oil is being pushed forward for burning purposes with a fair amount of success, but during the winter months should be left alone, unless used simply in small percentages with hardier oils, as during that period it is more often non-fluid than non-congealable after having reached the solid state. Colza and seal oils are the two oils in most demand, the latter being used more for collieries than otherwise.

The whale and sperm are seldom used alone, but are utilised more by refiners in the preparation of the first two oils.

In the case of colza, a refined Ravison rape is sometimes used when it is found necessary to add 15 per cent. Arctic sperm, so as to reduce the specific gravity down to that of refined rape.

In the case also of seal, when a pale whale oil is added thereto, a percentage of Arctic sperm is sometimes required when the specific gravity of either of the other two oils exceeds the usual limit, which often occurs when air has been used in refining.

Judging by some of the blends sent out lately, and the varied component parts they contain, the making of lamp oils seems likely to become a high art in the near future.

Below are a few of the latest blends :—

COLZA No. 1.

75 per cent. refined rape,
15 per cent. thickened rape,
10 per cent. mineral colza.

COLZA No. 2.

35 per cent. non-congealable cotton oil,
30 per cent. refined rape,
20 per cent. thickened rape,
15 per cent. mineral colza.

RAILWAY COLZA.

25 per cent. ·840 neutral,
25 per cent. thickened rape,
25 per cent. non-congealable cotton,
25 per cent. pale seal.

The above have a specific gravity equal to refined rape, and are scented to disguise their origin, which can be accomplished with the cycle oil scent already specified on page 39.

In doing this it is advisable to mix the foreign ingredients together first and neutralise their smell, so that the prevailing odour, when all are mixed together, may be that of the colza.

This does not, however, apply to No. 3 blend, which can be deodorised altogether.

No. 1 SEAL LUBRICATING AND BURNING.

45 per cent. seal,
45 per cent. non-congealable cotton,
5 per cent. ·980 lardine,
5 per cent. Arctic sperm.

No. 2 SEAL LUBRICATING AND BURNING.

40 per cent. seal,
20 per cent. ·980 lardine,
40 per cent. ·840 neutral.

SEAL LAMP OIL.

40 per cent. seal,
25 per cent. whale,
10 per cent. ·980 lardine,
25 per cent. mineral colza.

The aim of the manipulator in all of these blends has been, as far as possible, to retain the specific gravity in each oil, but this is not always necessary, unless a facsimile is required, in which case it is desirable, as far as possible, to work to that end.

Some firms prefer using seal and rape combined in making lamp oils, for which the following standard blend is recommended as a groundwork, to which the other oils requisite can be added as desired :—

45 per cent. pale seal,
35 per cent. refined Ravison rape,
20 per cent. Arctic sperm.

The important point necessary, in making any burning oil, is to compare it with a pure standard quality in actual work, as only by such means can a set of good, reliable standard qualities be secured.

Cheapness is not always beneficial, as there is only a certain limit to which this quality can go, below which no real satisfaction can be given.

In testing the burning qualities the points to ascertain are—the capillary attraction powers, time of burning, charring of wick, quantity used in comparison with the genuine oil, by which knowledge a reliable table of the respective standard qualities

can be drawn up and shown to the customer whenever necessary.

The following blends, chosen from several of the largest manufacturers' standard qualities, will furnish a good foundation, and give much help in the preparation of similar oils :—

RAILWAYS, STEAMSHIPS, ETC.

1 refined cotton (non-congealable),
1 castor, 1st pressings,
1 refined rape,
1 mineral colza.

---

5 refined rape,
4 refined cotton (non-congealable),
1 sweet Arctic sperm.

---

1 thickened rape,
1 pale seal,
1 mineral colza.

---

4½ thickened rape,
4½ Arctic sperm,
1 mineral colza.

---

1 refined Ravison rape,
1 mineral colza.

COLLIERY LAMP OILS.

4 pale seal,
1 mineral colza.

---

1 thickened rape,
1 seal oil,
1 imperial bloomless.

CYCLE OIL (burning and lubricating).

1 non-congealable cotton oil,
1 mineral colza (scented).

---

1 Arctic sperm,
1 mineral colza,
1 refined rape (scented).

---

9 sweet refined Arctic sperm,
1 mineral colza
(coloured ruby with cutch).

## PRACTICAL HINTS.

*Mixing.*—In using thickened rape or castor in conjunction with mineral colza, always blend the other oils used with the above heavy oils before adding the latter, otherwise a perfect combination may not result. Never use an oil that is not perfectly bright and free from moisture, as this hinders the capillary powers and likewise chars the wick.

*Specific Gravity.*—No lamp oil should be of heavier gravity than that of refined rape, *viz.*, ·916 at 60° F.—in fact, the lighter the body the better its burning power, so that it is not in any way compulsory or necessary to work for such so long as the other ingredients used are not of too volatile a nature, and burn freely without smoking, and compare favourably with that of pure oil.

| | 60° F. |
|---|---|
| Refined rape or colza - - - | ·914 to ·916. |
| Refined Ravison - - - - | ·919 to ·922. |
| Thickened rape - - - - | ·970 to ·975. |
| Non-congealable cotton oil - - | ·918 to ·920. |
| Pale seal oil - - - - - | ·924. |
| Pale whale oil - - - - - | ·920. |
| Mineral colza - - - - - | ·829. |
| American neutral - - - - | ·840. |
| Imperial bloomless - - - - | ·862. |

*Free fatty acids* and flash-points, see pages 45 and 50.

# CHAPTER VII.

## ENGINE TALLOW, SOLIDIFIED OILS AND PETROLEUM JELLIES.

### Engine Tallow.

As the old school of engineers are dying off, so is the use of tallow for direct lubrication declining. It will not, however, be wholly superseded by hydrocarbon oils, as a small percentage assists in a uniform lubrication being obtained without carbonisation, usually set up when mineral oils at high pressure are used alone.

For some purposes, also in conjunction with cylinder creams, it is found very beneficial, where a higher melting-point is desired than that possessed by the mineral oil, to add a requisite proportion up to even 50 per cent. to attain that end, provided the tallow is highly refined, and does not contain a higher percentage of free fatty acid than 3 per cent., for which purpose a good Australian mutton or beef will be found most suitable, the specific gravity of which ranges from ·937 to ·940.

There are also numerous other courses wherein a good tallow can be used, especially for foreign climates, *e.g.*:—

56 lb. Australian mutton,
50 lb. cosmos cylinder,
5¼ lb. yellow ceresin wax,
¾ lb. crushed soda crystals.

Melt tallow and wax together, and add thereto the soda crystals, well agitating. Having done this pour same into the cold cylinder oil, and stir continuously until nearly set.

50 lb. mutton tallow,
28 lb. cosmos cylinder,
28 lb. graphite,
5¼ lb. yellow ceresin wax,
¾ lb. crushed soda crystals.

Melt tallow, also wax, and add thereto the soda, which is then poured into cold cylinder oil, and when nearly set the graphite is stirred in.

### Russian Tallow.

The stock of above on the market is practically *nil.* What is sold as such is good Australian mutton and beef in equal proportions, and if required of a high melting-point the first named alone, which in melting-point and general appearance is practically identical.

In packing, however, the grain must not be

broken as in ordinary tallow, but allowed to seed.

The melting-point of Russian tallow is from 112° to 114° F., and at 212° F. it has a viscosity of 1·7, water = 1.

## Solidified Oils.

Great care and discretion are necessary in recommending the above. It is certainly not advisable to offer those made from mineral oils and soap, on account of the metallic action set up in working.

The majority of solidified oils on the market are really more of a grease than an oil, in the true sense of the term, as tallow enters freely into their construction.

Two very good qualities are given below :—

95 lb. extra filtered cylinder oil,
5 lb. refined cotton oil,
5 lb. tallow,
1 lb. slaked lime, } mixed.
6 lb. water, }

Melt cotton and tallow together, then stir in lime mixture, and add warm cylinder oil to 100° F., stirring well in until nearly set.

56 lb. extra filtered cylinder oil,
30 lb. ·908 Russian oil,
10 lb. bone tallow,
5¼ lb. yellow ceresin,
⅝ lb. powdered soda crystals.

Melt the last three ingredients together, also warm the cylinder oil to 100° F., then amalgamate the whole, stirring until nearly cold.

## Petroleum Jellies.

These are really the finest solidified oil extant, as they are thickened without the aid of foreign matter.

Many attempts have been made to make them in this country; but, not using the right oil, the result hitherto has been a failure.

The oil required for this purpose is what is known as American stock, and seems very difficult, if not impossible, to obtain, as the Yankees are reluctant to ship in the crude state.

A good quality can, however, be obtained at about £18 per ton, having a melting-point of about 104° F. and a flash-point of some 440° F. and upward, equal in colour and consistency to vaseline, from which, for lubricating purposes, with the aid of ceresin, etc., good qualities can be made in all shades, *e.g.*:—

### White.

65 lb. white mineral oil,
24 lb. best Calcutta castor,
23 lb. white ceresin.

PALE YELLOW.

34 lb. petroleum jelly,
67 lb. Queen's spindle,
5½ lb. ceresin wax,
5½ lb. soft paraffin scale.

The above are likewise suitable for domestic use, the latter quality being well adapted for veterinary purposes.

## CHAPTER VIII.

### MACHINERY GREASES: LOCO AND ANTI-FRICTION.

COMPOUNDS like "Stauffer's" grease are very good lubricants.

In making such, however, great care must be taken to see that, whichever of the oleates (lime, soda or alumina) is used, it is quite neutral, a fault noticeable in the majority of such greases.

Lead oleate should never be used for lubrication.

In no case is it necessary for the base to exceed that of the free fatty acid present in the oil or fat used (the richer in this respect the better), as the quality of the oleate is improved only according to such percentage present.

For such purposes, therefore, bone grease, palm oil and saponifiable Yorkshire stearine are the most suitable, as the percentage of free fatty acid in these articles always runs very high.

Greases made with sodium oleate are generally the worst, makers overlooking the fact that soda crystals contain two atoms of alkali, and use twice

the required quantity, with the result that, after a few days' standing, the surplus soda crystallises out.

In loco greases this often occurs, and is the cause of the rottenness so much complained of. Soda crystals are composed of about 106 parts of combined sodium, carbon and oxygen, and 180 of the water of crystallisation, which represents roughly a proportional quantity of 3 of the former to 5 of the latter.

Calculating the free fatty acids as oleic, for every 282 lb. of this article in any oil or fat it requires just 53 lb. sodium carbonate to convert this into an oleate and no more, so that when using soda crystals the necessary proportion required for this quality of oleic acid would be about 145 lb.

In making such greases also with lime and alumina oleates the same rule applies.

These kinds of greases open up a good source for the disposal of the refining bottoms of olive and neatsfoot oils, etc.

The ·903 American and Nobel's No. 1 are the best hydrocarbon oils for this purpose.

Cotton oil is also largely used, but if in the form of lardine it would be found to work in much better.

The cream and black cylinder oils seem to

be practically ignored for this purpose, on account of colour, but it would pay to adopt them, as their viscousness and tenacity would materially improve such greases, and, if energetically pushed, the colour prejudice, now somewhat prevailing, would speedily disappear.

Loco greases should never contain insoluble bases, but should be as the specimens given below, being much more beneficial than the old grades of palm oil and tallow, and superior in lubrication.

LOCOMOTIVE GREASE.

35 gallons ·903 American,
6 gallons Nobel's No. 1,
10 gallons saponifiable Yorkshire grease,
8 gallons liquefied soda crystals.

Melt stearine, and add thereto oils and cool down to about 110° F., at which temperature the soda is stirred in briskly.

40 lb. mutton tallow,
16 lb. saponifiable Yorkshire grease,
28 lb. ·908 Russian oil,
28 lb. soda crystals,
112 lb. water.

Melt tallow and stearine together; dissolve soda in the water and add the fat thereto at a temperature of 120° to 130° F., and when thoroughly combined gradually work in the oil, well agitating.

These greases are well liked for loco purposes on account of their splendid wearing and cooling properties.

Some makers of loco grease in the past have been so covetous that the largest users now prefer making their owr, but there is no reason why the lost ground should not be regained if a thoroughly good lubricant is offered at a fair and reasonable price.

### Anti-friction Greases.

The manufacturers of above seem at the present time to be following in the footsteps of some of the soap-makers, with this difference, that instead of using water they employ bases to the extent of 60 per cent., the majority of such being perfectly useless for lubrication, especially that of terra alba or mineral white.

The only bases of any real value are lime and talc, and these should not be used except in conjunction with resin or other fatty oils as a soap.

Anthracene or green oil is also used in the cheaper greases, but is not recommended.

The sooner consumers are convinced of the fallacy of buying such rubbish as many of the so-called greases are at present, and induced to purchase those containing genuine lubricating properties, the better, and the firms who push these

grades energetically will build up for themselves a good sound business.

The finest anti-friction grease on the market is that sold under the style of glycerine grease, for which fancy prices are obtained. The cost of manufacturing this quality, as well as that of genuine resin grease, is about £7 per ton.

Taking these two as standard qualities, there should be no difficulty for a set of greases being made therefrom that will contain good lubricating properties at remunerative prices.

In buying resin oil it is always advisable to first test its adaptability for grease-making. There is a suspicion that some distillers supply unsuitable qualities.

In buying, therefore, it is advisable to always ask for grease-making grades.

Good, cheap, black residuums, also the paler mineral oils, likewise foots and tank bottoms, wool fats, etc., if free from mineral acid, will be found most suitable for making anti-friction greases. The following blends will be found to give satisfaction :—

WHITE GREASES.

| | |
|---|---|
| 102 lb. soft resin oil,<br>10 lb. cream of lime,<br>56 lb. ·885 oil, | No 1. |
| 112 lb. soft resin oil,<br>28 lb. talc. | No 2. |

YELLOW GREASE.

98 lb. soft resin oil,
10 lb. liquefied soda crystals,
4 lb. palm oil.

BLACK FLOATING GREASE.

1 cwt. Anglo-American summer dark,
1 cwt. talc.

BLACK GREASE.

50 lb. soft resin oil,
10 lb. liquefied soda crystals,
26 lb. Nobel's black residuum,
26 lb. talc.

GLYCERINE GREASE.

72 lb. soft resin oil,
20 lb. ·885 American,
20 lb. glycerine mixture.

In this grade mix the first two together, then add the mixture (hot), well stirring.

GLYCERINE MIXTURE.

4 cwt. medium soft resin oil,
1 cwt. slaked sifted lime.

To prepare the lime spread it out on a floor, and slack by sprinkling thereon sufficient water (about 3 gallons to each bushel), and when completely powdered sieve through a fine mesh, when it will be ready for use.

Place resin oil in pan and heat from 250° to 300° F., and gradually add thereto the lime, well

stirring. When finished, the oil should resemble syrup in appearance.

Be very careful to keep all lights away from oil, and have a hood placed over pan leading to chimney shaft or other receptacle, with good draught to carry away the vapour, as the oil is at its firing-point when it reaches the maximum temperature specified.

## Practical Hints.

*Fatty Acids.*—The quantity of base required is ruled by the percentage present.

In resin oil this is calculated as acetic, whereas in all other oils and fats it is taken as oleic.

*Acetic Acid.*—The atomic weight of this is 60. Therefore, in testing resin oils the multiple quantity would be that enumerated above instead of 282 (see p. 52).

Quantity of bases required to neutralise 282 lb. oleic and 60 lb. acetic acid :—

*Lime.*—56 lb. quicklime (calcium oxide).

*Milk of Lime.*—To each bushel of lime add 22 gallons water, but to allow for impurities 1¼ bushels or 70 lb. is required so as to attain a full strength cream. When thoroughly slaked, pass it through a fine sieve into store tank for use, when each gallon should contain about 2½ lb. lime if stirred well together on using.

*Talc.*—52 lb. (silicate magnesia).

*Alumina.*—61 lb. oxide alumina.

This should only be used with greases containing oleic acid, such as bone or Yorkshire grease, both of them containing about 20 per cent. free fatty acid, which enables good lubricants of high melting-point to be made, for which fancy prices are obtained.

The alumina required is best dissolved in glycerine 1·260 specific gravity (as small a quantity as possible), and then poured gradually into the fat at a temperature of 160° F., and kept well stirred until it cools to the consistency of cream, when a little scent such as given on page 39 can be added if desired.

*Yorkshire Grease.*—As the quality of this article is very variable it requires careful supervision when being purchased, as some grades contain very little animal matter, and are therefore wholly unsuitable for grease-making. Nothing that contains less than 60 per cent. saponifiable fats is recommended. Its average melting-point is about 110° F., and that of bone tallow 95° F.

A good working blend is composed of 25 per cent. of the former to 75 per cent. of the latter.

*Resin Oil.*—The best quality suitable for grease-making is that known as "medium soft," having a specific gravity of about ·990.

*Cohesion.*—A much better amalgamation is obtained when the oils are warmed instead of being used cold, especially during the winter months, that of 120° F. being found the best combining heat.

This does not apply to mineral oils, which blend better cold.

## CHAPTER IX.

### CLARIFYING AND UTILISATION OF WASTE FATS, OILS, TANK BOTTOMS, DRAININGS OF BARRELS AND DRUMS, PICKINGS-UP, DREGS, ETC.

THE great object in any oil works should be to utilise everything. Nothing is more annoying than to see accumulations. In some works where the writer has been the quantity has been enormous.

All that is required are four small pans fitted with a steam coil, *viz.*:—

No. 1 Animal and vegetable fats, oils, etc.
No. 2 Pale mineral oil.
No. 3 Dark mineral oil.
No. 4 Linseed, boiled oils and varnish.

When full, heat up to 170° F., well agitating. Then sprinkle in dry a mixture of 6 lb. powdered alum, 1½ cream tartar, to every cwt. (without crutching), and allow to settle for twelve hours, when same can be skimmed off bright and ready for further use.

Any water lying at bottom of pan should now be drawn or pumped off, and the dregs passed

through a fine sieve or muslin, and this can be used up either in a grease or in conjunction with a black oil for chains, etc.

By the adoption of such a system everything is periodically utilised, and the massing of ullages and waste matter entirely avoided.

# CHAPTER X.

## THE FIXING AND CLEANING OF OIL TANKS, ETC.

NINETY per cent. of the complaints from customers arise from the oil having been either stored in dirty tanks or filled into dirty barrels or drums, through which carelessness much annoyance is caused to customers, resulting sometimes in losing them, besides the allowance or return that has generally to be made in such cases.

### FIXING AND FILLING OF TANKS.

In fixing these into position it is essential to see that they slope well, so that the bottoms can be drawn off periodically from the lower tap, as there is always a deposit accumulating, especially from air-dried oils.

When pumping in fresh supplies on top of those already present, it is best to arrange for the incoming oil to hit either the top or side of the tank, instead of falling directly into the existing oil, which will prevent the bottom portion being disturbed.

It is also advisable to draw off, as far as possible, any thick oil or deposit that may be there before so doing.

### Cleaning Tanks.

After clearing out all the oil, the most effectual way is to fill the tanks with water, and add for every ton capacity 15 lb. caustic soda and 1 lb. permanganate potash, previously dissolved in hot water, and then to fix therein a steam pipe, and well boil and allow to stand overnight, which will completely remove all extraneous matter, and can be then run away.

After wiping out the tank prepare a lime wash as under, and apply to the inside walls, which, when dry, will render them perfectly sweet, and act likewise as a preservative to the oil from any action of the iron.

1 bushel lime,
1 gallon silicate soda, 100°,
1 gallon water,

thinned to desired consistency.

### Barrels, Casks and Drums.

When returned from a customer, after the ordinary draining, it is advisable in every instance to wash these out thoroughly before again using. The same cleanser as recommended for tanks is

most suitable for this purpose, but should be made in a concentrated form, *viz.* :—

22 lb. caustic soda,
1½ lb. permanganate potash,

dissolved in a barrel of water.

For barrels use about half a gallon, and for casks quantities *pro rata*, according to capacity. For drums, cans, etc., to prevent accumulation, it is advisable to have a large tank or tub continually charged, so that they can be immersed therein as they arrive, into which any exhaust steam can be run, so as to keep the water continually on the simmer. When thoroughly cleansed, rinse out with hot water containing 1 lb. salt to each barrel, and allow to drain thoroughly, when it should be again rinsed with a little methylated spirit, so as to remove any remaining moisture. Rinse the drums and cans in the same way ; paint immediately, and store.

A good quick-drying paint is made as under :—

½ cwt. common powdered resin,
10 gallons naphtha,
14 lb. burnt umber,
14 lb. driers,
2 gallons raw linseed.

To dissolve the resin put it into a double-headed barrel, and pour thereon the naphtha,

after which bung up tightly and roll about periodically until dissolved; then draw off some of the liquid, and mix therein the umber and driers, also the oil, and return the whole to the barrel, well mixing before using. This paint dries in about five minutes with a fine gloss, and can be made in any shade, as desired.

For drums and cans it is advisable to strain before use, as the resin is sure to contain dirt, but for barrel heads it is not necessary. Keep well bunged up and away from naked lights when not using. A great mistake made by a good many firms is to use, for cheapness, ordinary "black" drums for oils, which are most unsuitable, and are the cause of many complaints, as oils (especially animal and vegetable) set up a metallic action on the iron, which discolours them considerably if allowed to stand for any period therein.

For home trade the cheapest, most lasting and most satisfactory drum is that which is tin-lined, but as its price renders it prohibitive for general use those lead-coated can be utilised for mineral and paint oils; for the better class, such as neatsfoot, lard, olive, sperm, etc., also turpentine and other spirits, the former package should always be used.

To keep these distinct a different coloured paint on the respective drums is advisable, so as to render

them easily distinguishable, and so prevent any possible error arising.

The adoption of such a method, and the continuous careful supervision in the cleansing of returned packages, as well as the final examination of oils from drums and barrels before despatch, would materially minimise, if not altogether prevent, the complaints hitherto so prevalent through dirty tanks and packages.

# APPENDIX OF GENERAL INFORMATION.

*Specific Gravity.—Liquids.*—For oils see page 16. For acids, lyes, etc., a Twaddell or Beaumé hydrometer is used.

The Beaumé glass, however, is not recommended, having no definite formation or fixed scale of gradation.

The zero of a Twaddell glass is that of distilled water at 60° F., every degree after being equivalent to five of real specific gravity.

To convert degrees (Twaddell) into real specific gravity multiply their number by 5, add the result to 1000, and then divide by 1000.

Thus: 24 T. × 5 = 120 + 1000 = 1120
÷ 1000 = 1·120 specific gravity.

To ascertain this accurately, a specific gravity bottle is required with drilled stopper and counterpoise, those holding 100 grains being a suitable size.

Having seen that the flask is quite clean and dry it is counterpoised on the balance, and then

filled with distilled water previously brought to the temperature of 60° F., and again weighed to check its water capacity, which henceforth becomes the unity of all future weighings.

Now thoroughly cleanse bottle with spirit and dry, then fill with the desired liquid and weigh.

By dividing its weight by that of the water (less bottle), the specific gravity will result.

*Solids Heavier than Water.*—Weigh in air suspended from the pan of the balance by a fibre of unspun silk, then in distilled water.

Suppose a substance which weighs in air 420 grains, and in water 345, the weight lost by immersion is found to be 75 grains—

$$\therefore 420 \div 75 = 5{\cdot}6$$

which is therefore the density or specific gravity of the article in question.

*Solids Lighter than Water.*—With waxes and such substances, distilled water and methylated spirit of a known gravity are generally taken and manipulated until the material just floats therein, at which point the specific gravity of the mixture is taken to be that of the solid also.

To be exact, after weighing in air it will be necessary, when doing so in water, to attach thereto some heavier substance to enable it to sink therein,

which must be afterwards weighed separately and deducted therefrom.

As an example :—

| | |
|---|---|
| Light solid weighed in air - - - | 21 grs. |
| Heavy solid weighed in air - - - | 34 „ |
| Heavy solid weighed in water - - | 25 „ |
| Light and heavy solids weighed in water | 16 „ |
| Combined weight in air (21 + 34) - | 55 „ |
| Combined weight in water - - - | 16 „ |
| | 39 „ |
| Difference of heavy solid in air and water (34 – 25) - - - - - | 9 „ |
| | 30 „ |

$\therefore 21 \div 30 = \cdot 7$

this being the specific gravity of the lighter body taken.

All weighings, etc., are taken at normal temperature, *viz.*, 60° F.

*Tons into gallons.*—To find same reduce to pounds (2240) and divide by the specific gravity. For example, oil taken has a specific gravity of ·905, $\therefore$ 2240 ÷ ·905 = 247·5 or 247½ gallons.

In buying it is always advisable to purchase by weight wherever possible. Olive oil, however, is an exception, being sold at per *tun* of 252 gallons.

In selling the trade custom is to calculate all oils at 9 lb. per gallon, with the exception of sperm and castor, which are taken at 8¾ lb. and 9½ lb. respectively.

With mineral oils, however, ranging under ·890 gravity, the calculation per gallon is similar to that of sperm.

*Price per gallon from price per ton.*—Take the gross cost per ton and divide by the number of gallons contained therein, *e.g.*, gross cost of oil containing 247½ gallons, £7 14s. 6d. per ton.

As there is an odd half-gallon it is advisable to reduce the amount to pence, *viz.*, 1854 ÷ 247·5 = 7·49, or 7½d. per gallon.

*Price per gallon to price per ton.*—Multiply the number of gallons present according to the specific gravity if buying, but if selling either by 249 (general oils), 256 (sperm and light mineral oils), or 236 (castor) respectively by the price per gallon.

*Price from per ton to per cwt., also to per lb., likewise the fractional parts of a penny per ton.*—Each £1 per ton is equivalent to 1s. per cwt.; in the same way every 2s. 6d. per ton (the minimum market rise and fall) corresponds to 1½d. per cwt.

To ascertain the price per lb. from that of per cwt. divide by 7 and multiply by 3, the result of which will be in farthings.

For example, £1 0s. 10½d. per cwt., how much per lb.?

Owing to the price containing the fractional parts of a shilling it is easier to reduce same to

decimals, *viz.*, 20·875 ÷ 7 = 2·982 × 3 = 8·9464 farthings per lb.

When the amount, however, is composed of whole numbers only, say 21s., this rule is very rapid :—

21 ÷ 7 = 3 × 3 = 9, or 2¼d. per lb.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1d. | per lb. | increases | or | decreases | the price | per ton | £9 6 8 |
| ⅞ | ,, | ,, | ,, | ,, | | | 8 3 4 |
| ¾ | ,, | ,, | ,, | ,, | | | 7 0 0 |
| ⅝ | ,, | ,, | ,, | ,, | | | 5 16 8 |
| ½ | ,, | ,, | ,, | ,, | | | 4 13 4 |
| ⅜ | ,, | ,, | ,, | ,, | | | 3 10 0 |
| ¼ | ,, | ,, | ,, | ,, | | | 2 6 8 |
| ⅛ | ,, | ,, | ,, | ,, | | | 1 3 4 |
| 1/16 | ,, | ,, | ,, | ,, | | | 0 11 8 |
| 1/32 | ,, | ,, | ,, | ,, | | | 0 5 10 |

TABLE OF APPROXIMATE QUANTITY OF GALLONS PER TON IN STANDARD OILS ACCORDING TO THEIR SPECIFIC GRAVITY.

*Hydrocarbon Oils :—*

| | Sp. Grav. | Gallons. |
|---|---|---|
| Mineral colza - - - | ·829 | 270½ |
| American neutral oil - - | ·840 | 266½ |
| Pale Scotch mineral - - | ·860 | 260½ |
| Do. do. - - | ·875 | 256 |
| American cosmos cylinder - | ·875 | 256 |
| American spindle - - | ·885 | 253 |
| American extra fil. cylinder - | ·890 | 251¾ |
| Queen's spindle - - - | ·895 | 250¼ |
| American XXX. valve - | ·895 | 250¼ |
| Russian No. 2 - - - | ·895 | 250¼ |
| N. cylinder - - - - | ·900 | 249 |
| American pale machinery - | ·903 | 248 |

| | Sp. Grav. | Gallons. |
|---|---|---|
| American H. V. - - - | ·907 | 247 |
| Russian No. 1 - - - | ·908 | 246¾ |
| Bayonne - - - - | ·915 | 244¾ |
| Heavy Russian - - - | ·920 | 243½ |

*Hydrocarbon Spirit:—*

| | Sp. Grav. | F. Point, close. | Gallons. |
|---|---|---|---|
| American turps. - | ·864 | 94° F. | 259¼ |
| Russian turps.- - | ·870 | 107° ,, | 257½ |
| Rect. resin spirit - | ·872 | 84° ,, | 257 |

In selling, turpentine is worked out at 8½ lb. to the gallon, or 263½ gallons per ton.

*Purity.*—Turpentine has a fixed boiling-point of 320° F. On paper, when dipped therein and dried, it should leave no stain, any trace of which denotes presence of an oil, probably petroleum.

The specific gravity should never go below ·860 at 60° F.

Pure American turpentines are devoid of any colour, whereas Russian turpentines and resin spirit show a yellow tinge.

*Fatty Oils:—*

| | Sp. Grav. | Gallons. |
|---|---|---|
| Sperm - - - - | ·880 | 254½ |
| Tallow or ox - - - | ·914 | 244¾ |
| Olive - - - - - | ·915 | 244¾ |
| Neatsfoot - - - - | ·915 | 244¾ |
| Lard - - - - - | ·916 | 244½ |
| Rape - - - - - | ·915 | 244¾ |

| | Sp. Grav. | Gallons. |
|---|---|---|
| Rape Ravison - - - | ·920 | 243½ |
| Cotton refined - - - | ·922 | 243 |
| Seal pale - - - - | ·924 | 242½ |
| Whale - - - - | ·925 | 242 |
| Nut - - - - - | ·925 | 242 |
| Cocoa-nut - - - - | ·930 | 241 |
| Fish - - - - - | ·930 | 241 |
| Linseed raw - - - | ·934 | 240 |
| Do. boiled - - - | ·944 | 237¼ |
| Palm kernel - - - | ·950 | 235¾ |
| Do. lagos - - - | ·924 | 242½ |
| Castor - - - - - | ·964 | 232⅓ |
| Thickened rape - - - | ·965 | 232 |
| Do. - - - | ·970 | 231 |
| Do. - - - | ·975 | 230 |
| Lardine - - - - | ·960 | 233⅓ |
| Do. - - - - | ·970 | 231 |
| Do. - - - - | ·985 | 227½ |
| Water - - - - | 1·000 | 224 |

## METRIC SYSTEM.

The weight of 1 cubic centimetre of distilled water at its maximum density (4° C.) is taken as the unit of weight, and is called a gramme.

### MEASURES OF WEIGHT.

15·432 grains = 1 gramme.

28·349 grammes or 437·5 grains = 1 oz.

1000 grammes or 1 kilogramme = 2 lb. 3¼ oz.

103651

50·802 kilos = 1 cwt.
1016 kilos = 1 ton.
48 pennies, 80 halfpennies or 160 farthings = 1 lb.
3 pennies, 5 halfpennies or 10 farthings = 1 oz.

### Measures of Capacity.

One gallon of distilled water contains 4543 c.c., and weighs 70,000 grains, 4543 grammes or 10 lb. at 60° F.

1136 c.c. = 1 quart, and weigh 40 oz.
564 c.c. = 1 pint, ,, 20 ,,
1000 c.c. = 1 litre, ,, 35½ ,,
100 c.c. = $\frac{1}{10}$ litre, ,, 3½ ,,

The weight and volume of water are seen to be identical.

With other liquids the volume in c.c. × specific gravity = weight in grammes.

1 cubic inch is equal to 16·38 c.c.
227¼ cubic inches contain 1 gallon.
1 cubic foot contains 6·24 gallons.

### Measuring Tanks, etc.

*Circular.*—Square diameter and multiply by depth, reducing all measurements to inches, and divide by 359, which will give the contents in gallons.

This rule is sufficiently near for rough approximation, but if required accurately, the following rule should be used :—

Square diameter and multiply result by 0·7854, which will furnish the area, and on multiplying this by the depth, the cubical contents.

If result is in inches, divide by 277¼, but if in cubic feet, multiply by 6·24, both of which will give the contents in gallons.

*Square.*—Multiply the length by the breadth, also by the depth, which will show the quantity present in cubic feet, which, on multiplying by 6·24, gives contents in gallons, *e.g.* :—

Length, 8′ 4″ ; breadth, 5′ 0″ ; depth, 7′ 4″.

| | | |
|---|---|---|
| 8′ 4″ | 41′ 8″ | 305′ 6″ |
| 5′ 0″ | 7′ 4″ | 6·24 |
| 41 8 | 291 8 | 12224 |
| | 13 10 | 6112 |
| | 305 6 | 18336 |
| | | 1906·944 or |

practically 1907 gallons.

1728 cubic inches = 1 cubic foot.

### Thermometers.

*Centigrade to Fahrenheit.*—Multiply number of degrees by 9, divide the product by 5 and add 32, *i.e.* :—

49° C. × 9 = 441 ÷ 5 = 88·2 + 32 = 120·2° F.

*Fahrenheit to Centigrade.* — Subtract 32 from

number of degrees, multiply by 5 and divide by 9, *i.e.* :—

$$120{\cdot}2^\circ \text{ F.} - 32 = 88{\cdot}2 \times 5 = 441 \div 9 = 49^\circ \text{ C.}$$

*Water.*—

| | |
|---|---|
| Boiling-point | 212° F. / 100° C. |
| Freezing-point | 32° F. / 0° C. |
| Latent heat | 40° F. / 4·4° C. |
| Thermal heat | 79° F. / 26·1° C. |

*Steam.*—Thermal heat, 536°.

For every 772 units of work done, one unit of heat disappears.

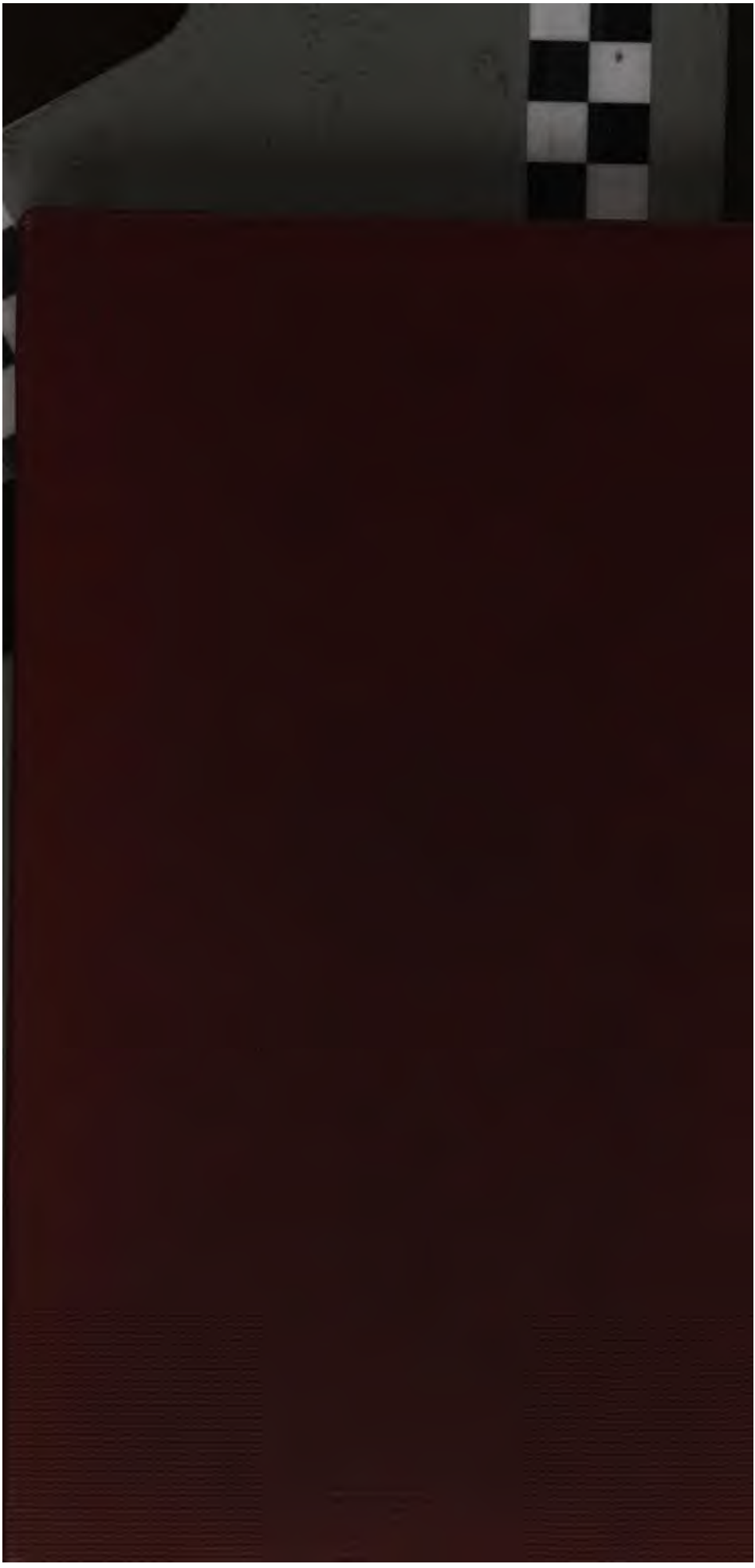
A unit is the amount of heat required to raise each lb. of water from 32° to 33° F., and so on, up to 212° F.

## TABLE OF THE CORRESPONDING DEGREES OF FAHRENHEIT AND CENTIGRADE THERMOMETERS FROM 212° F. TO 0° F.

| Fah. | Cent. | Fah. | Cent. | Fah. | Cent. |
|---|---|---|---|---|---|
| 212 | 100 | 189·5 | 87·5 | 167 | 75 |
| 211 | 99·4 | 189 | 87·2 | 166 | 74·4 |
| 210·2 | 99 | 188·6 | 87 | 165·2 | 74 |
| 210 | 98·9 | 188 | 86·6 | 165 | 73·9 |
| 209·7 | 98·7 | 187·2 | 86·2 | 164·7 | 73·7 |
| 209 | 98·3 | 187 | 86·1 | 164 | 73·3 |
| 208·4 | 98 | 186·8 | 86 | 163·4 | 73 |
| 208 | 97·8 | 186 | 85·5 | 163 | 72·7 |
| 207·5 | 97·5 | 185 | 85 | 162·5 | 72·5 |
| 207 | 97·2 | 184 | 84·4 | 162 | 72·2 |
| 206·6 | 97 | 183·2 | 84 | 161·6 | 72 |
| 206 | 96·6 | 183 | 83·9 | 161 | 71·6 |
| 205·2 | 96·2 | 182·7 | 83·7 | 160·2 | 71·2 |
| 205 | 96·1 | 182 | 83·3 | 160 | 71·1 |
| 204·8 | 96 | 181·4 | 83 | 159·8 | 71 |
| 204 | 95·5 | 181 | 82·7 | 159 | 70·5 |
| 203 | 95 | 180·5 | 82·5 | 158 | 70 |
| 202 | 94·4 | 180 | 82·2 | 157 | 69·4 |
| 201·2 | 94 | 179·6 | 82 | 156·2 | 69 |
| 201 | 93·9 | 179 | 81·6 | 156 | 68·9 |
| 200·7 | 93·7 | 178·2 | 81·2 | 155·7 | 68·7 |
| 200 | 93·3 | 178 | 81·1 | 155 | 68·3 |
| 199·4 | 93 | 177·8 | 81 | 154·4 | 68 |
| 199 | 92·7 | 177 | 80·5 | 154 | 67·7 |
| 198·5 | 92·5 | 176 | 80 | 153·5 | 67·5 |
| 198 | 92·2 | 175 | 79·4 | 153 | 67·2 |
| 197·6 | 92 | 174·2 | 79 | 152·6 | 67 |
| 197 | 91·6 | 174 | 78·8 | 152 | 66·6 |
| 196·2 | 91·2 | 173·7 | 78·7 | 151·2 | 66·2 |
| 196 | 91·1 | 173 | 78·3 | 151 | 66·1 |
| 195·8 | 91 | 172·4 | 78 | 150·8 | 66 |
| 195 | 90·5 | 172 | 77·7 | 150 | 65·5 |
| 194 | 90 | 171·5 | 77·5 | 149 | 65 |
| 193 | 89·4 | 171 | 77·2 | 148 | 64·4 |
| 192·2 | 89 | 170·6 | 77·0 | 147·2 | 64 |
| 192 | 88·8 | 170 | 76·6 | 147 | 63·9 |
| 191·7 | 88·7 | 169·2 | 76·2 | 146·7 | 63·7 |
| 191 | 88·3 | 169 | 76·1 | 146 | 63·3 |
| 190·4 | 88 | 168·8 | 76 | 145·4 | 63 |
| 190 | 87·8 | 168 | 75·5 | 145 | 62·7 |

| Fah. | Cent. | Fah. | Cent. | Fah. | Cent. |
|---|---|---|---|---|---|
| 144·5 | 62·5 | 120 | 48·9 | 96·8 | 36 |
| 144 | 62·2 | 119·7 | 48·7 | 96 | 35·5 |
| 143·6 | 62 | 119 | 48·3 | 95 | 35 |
| 143 | 61·6 | 118·4 | 48 | 94 | 34·4 |
| 142·2 | 61·2 | 118 | 47·7 | 93·2 | 34 |
| 142 | 61·1 | 117·5 | 47·5 | 93 | 33·9 |
| 141·8 | 61 | 117 | 47·2 | 92·7 | 33·7 |
| 141 | 60·5 | 116·6 | 47 | 92 | 33·3 |
| 140 | 60 | 116 | 46·6 | 91·4 | 33 |
| 139 | 59·4 | 115·2 | 46·2 | 91 | 32·7 |
| 138·2 | 59 | 115 | 46·1 | 90·5 | 32·5 |
| 138 | 58·8 | 114·8 | 46 | 90 | 32·2 |
| 137·7 | 58·7 | 114 | 45·5 | 89·6 | 32 |
| 137 | 58·3 | 113 | 45 | 89 | 31·6 |
| 136·4 | 58 | 112 | 44·4 | 88·2 | 31·2 |
| 136 | 57·7 | 111·2 | 44 | 88 | 31·1 |
| 135·5 | 57·5 | 111 | 43·9 | 87·8 | 31 |
| 135 | 57·2 | 110·7 | 43·7 | 87 | 30·5 |
| 134·6 | 57 | 110 | 43·3 | 86 | 30 |
| 134 | 56·6 | 109·4 | 43 | 85 | 29·4 |
| 133·2 | 56·2 | 109 | 42·7 | 84·2 | 29 |
| 133 | 56·1 | 108·5 | 42·5 | 84 | 28·9 |
| 132·8 | 56 | 108 | 42·2 | 83·7 | 28·7 |
| 132 | 55·5 | 107·6 | 42 | 83 | 28·3 |
| 131 | 55 | 107 | 41·6 | 82·4 | 28 |
| 130 | 54·4 | 106·2 | 41·2 | 82 | 27·7 |
| 129·2 | 54 | 106 | 41·1 | 81·5 | 27·5 |
| 129 | 53·9 | 105·8 | 41 | 81 | 27·2 |
| 128·7 | 53·7 | 105 | 40·5 | 80·6 | 27 |
| 128 | 53·3 | 104 | 40 | 80 | 26·6 |
| 127·4 | 53 | 103 | 39·4 | 79·2 | 26·2 |
| 127 | 52·7 | 102·2 | 39 | 79 | 26·1 |
| 126·5 | 52·5 | 102 | 38·9 | 78·8 | 26 |
| 126 | 52·2 | 101·7 | 38·7 | 78 | 25·5 |
| 125·6 | 52 | 101 | 38·3 | 77 | 25 |
| 125 | 51·6 | 100·4 | 38 | 76 | 24·4 |
| 124·2 | 51·2 | 100 | 37·7 | 75·2 | 24 |
| 124 | 51·1 | 99·5 | 37·5 | 75 | 23·8 |
| 123·8 | 51 | 99 | 37·2 | 74·7 | 23·7 |
| 123 | 50·5 | 98·6 | 37 | 74 | 23·3 |
| 122 | 50 | 98 | 36·6 | 73·4 | 23 |
| 121 | 49·4 | 97·2 | 36·2 | 73 | 22·7 |
| 120·2 | 49 | 97 | 36·1 | 72·5 | 22·5 |

### Trade Abbreviations.

C.I.F.—Cost, insurance and freight paid.
F.A.S.—Free alongside.
F.O.B.—Free on board.
F.O.R.—Free on rails.
S. to S.—Station to station.
C. & D.—Collected and delivered.
D/d.—Delivered.
C.A.S.—Cash at sight.
C.A.B./L.—Cash against bills of lading.
C.A.M.R.—Cash against mate's receipt.
E. & O. E.—Errors and omissions excepted.

THE END.